

## **Administrative Procedure**

# **CPCC-PRO-SH-40112**

PRC-PRO-SH-40112

## **Roof Assessment Process**

Revision 0, Change 0

Published: 03/09/2021

Effective: 03/09/2021

Program: Occupational Safety and Industrial Hygiene

Topic: Occupational Safety and Industrial Health

Technical Authority: Coffland, Katherine

Functional Manager: Smith, Courtney

## **Use Type: Administrative**



- Solid Waste Operations Complex :  
**Screening Determination Performed: (Screening/Determination Performed (no issues))**  
SWOC-21-013  
**Screener:** Jacobs, Orvil
- Canister Storage Building/Interim Storage Area :  
**Screening Determination Performed: (Screening/Determination Performed (no issues))**  
CSB-21-007  
**Screener:** Garrett, Robert
- Central Plateau Surveillance and Maintenance :  
**Screening Determination Performed: (Screening/Determination Performed (no issues))**  
S&M-21-020  
**Screener:** Mart, Eva
- Waste Encapsulation Storage Facility :  
**Screening Determination Performed: (Screening/Determination Performed (no issues))**  
WESF-21-047  
**Screener:** Garrett, Robert
- 100 K Facility :  
**Categorical Exclusion:** GCX-8 (Not in Safety Basis Compliance Matrices)  
**Screener:** Oberg, Brian
- Plutonium Finishing Plant :  
Excluded from USQ  
**Exclusion Reason:**  
Per Sect. 1.3. PFP does not have any Nuclear Facility buildings subject to procedure applicability.
- Transportation :  
Excluded from USQ  
**Exclusion Reason:**  
N/A per Section 1.3
- 324 Facility :  
**Screening Determination Performed: (Screening/Determination Performed (no issues))**  
324-21-025  
**Screener:** Enghusen, Mark
- PFP Ancillary Structures :  
Excluded from USQ  
**Exclusion Reason:**  
Per Sect. 1.3

**JHA:** Administrative

**Periodic Review Due Date:**03/09/2026

Rev. 0, Chg. 0

## Change Summary

## Description of Change

Procedure revision in response to CR-2020-1073.

General Editorial changes in punctuation, grammar and tense usage were made to improve readability.

1.2 Redefined Scope to include the new Contractors name and a broadened Scope.

1.3 Clarified criteria under the Good Faith Roof Assessment or Engineering Inspection requirement.

3.1.1 Provided a link to the status of existing Good Faith Roof Assessment.

3.1.3 Removed Crystal Report CARETAKER as a resource.

3.1.4 Added DOE-0346 Hanford Site Fall Protection Program as a reference.

3.2.2 Replaced PRC-PRO-WKM-079 Job Hazards Analysis with CPCC-PRO-WKM-14047 Pre-Job Briefings and Post-Job Reviews.

3.2.4 Added the requirement to immediately notify the Building Manager of any identified safety issues.

3.2.8 Edited the completed copy of the Good Faith Roof Assessment submittal process.

3.3.2-3.3.4 Revised the process of conducting an Engineering Inspection.

3.4.1 Edited the completed copy of the Good Faith Roof Assessment submittal process.

5.0 Edited the record identification section in accordance to a CPCCo Records Management Specialist review.

6.2 Revised the list of references.

Added Appendix A Generic Roof Inspection Plan.

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**Roof Assessment Process****Published Date: 03/09/21****PRC-PRO-SH-40112****Effective Date: 03/09/21****1.0 INTRODUCTION****1.1 Purpose**

This procedure defines the process for determining the capability of a roof to support the personnel, equipment, and/or materials required to perform a planned activity.

This activity was initiated as a corrective action in response to a 1992 fatality at Hanford's 105-F Building.

**1.2 Scope**

This procedure applies to all Central Plateau Cleanup Company (CPCCo)-assigned structures.

**1.3 Applicability**

- Roofs on all CPCCo assigned structures shall receive and pass a good faith roof assessment or engineering inspection prior to employee roof access.
- Containerized cargo containers are exempt from this procedure.
- The following structures require only a good faith roof assessment prior to employee access:
  - Roofs of mobile offices with no known current structural defects.
  - Roofs of maintained structures with no known current structural defects.
- The following types of roofs require an engineering inspection:
  - Roofs of unmaintained or abandoned structures.
  - Roofs of structures suspected to have structural damage or extensive water damage.
- A good faith roof assessment is not required if written documentation provided by a qualified engineer states that the structural integrity of the roof(s) is adequate for the type of work to be performed,
- Neither a good faith roof assessment or engineering inspection is required if:
  - The criteria listed under 3.1.2 "Previous Assessments" are met, or
  - Written documentation provided by a qualified engineer states that the structural integrity of the roof(s) is adequate for the type of work to be performed.

**1.4 Implementation**

- This procedure replaces HNF-PRAC-30498, *Roof Assessment Procedure*.
- This procedure is effective upon publication.

**2.0 RESPONSIBILITIES**

Responsibilities are as outlined in Section 3.0, "Process."

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## 3.0 PROCESS

## 3.1 Roof Access Pre-Planning

Actionee	Step	Action
<b>NOTE:</b>	<i>The date of the last Good Faith Roof Assessment and/or engineering inspection is available by accessing the Hanford Missions Integration Solutions (HMIS) Real Estate Services Roof Inspection Report</i>	
Planner/ Scheduler, or Manager	1.	<p>DETERMINE if the date of the most recent <a href="#">Good Faith Roof Assessment</a> and/or engineering inspection is within limits for use on a task requiring roof access.</p> <ul style="list-style-type: none"> <li>Print the specific file if the subfolder information indicates the <i>Good Faith Roof Assessment</i> and/or engineering inspection was conducted within the acceptable time frame (1 year for a <i>Good Faith Roof Assessment</i> and as indicated in the engineering inspection report).</li> <li>Place the printout in the work package.</li> </ul>
	2.	<p>DETERMINE if previous assessments or inspections may be used provided the following criteria are met:</p> <ul style="list-style-type: none"> <li>Assessment or inspection is considered "passed"</li> <li>Assessment or inspection is signed by those performing the review</li> <li>Load limits (personnel, equipment, materials, and refuse) stated will not be exceeded</li> <li><i>Good Faith Roof Assessment</i> is less than 1 year old</li> <li>Engineering inspection duration of use has not been exceeded that which is listed in the inspection documentation</li> </ul>
	3.	<p>NOTIFY the Building Manager of the need for a new <i>Good Faith Roof Assessment</i> or engineering inspection if the Hanford Missions Integration Solutions (HMIS) Real Estate Services <i>Roof Inspection Report</i> information indicates the timeframe between evaluations has been exceeded.</p>
	4.	<p>REFER to DOE-0346, <i>Hanford Site Fall Protection Program</i>, for any fall protection system requirements, including guardrails, for any locations where exposure to a fall hazard may exist.</p>
Building Manager (or delegate)	5.	<p>SCHEDULE a <i>Good Faith Roof Assessment</i> or engineer inspection as requested to support pre-job planning of a task requiring roof access.</p>

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## 3.2 Good Faith Roof Assessment

Actionee	Step	Action
Building Manager (or delegate)	1.	ASSEMBLE team to conduct a good faith roof assessment. <ul style="list-style-type: none"> <li>The team consists of a minimum of three members: the Building Manager (or delegate), an engineer, and a project safety professional. The Union Safety Representative may be considered as an optional Team member</li> </ul>
	2.	CONDUCT a pre-job briefing with the team per CPCC-PRO-WKM-14047, <i>Pre-Job Briefings and Post-Job Reviews</i> .
Assessment Team Members	3.	COMPLETE a self-study of this procedure prior to participating in an assessment.
	4.	COMPLETE the <i>Good Faith Roof Assessment</i> (Site Form A-6004-781), including: <ul style="list-style-type: none"> <li>OBTAIN <u>AND</u> RECORD the weight of the intended load to be placed on the roof during the activity (number of employee's times 300 lb, plus the weight of equipment, plus the weight of materials).</li> <li>ASSESS the structure's outer and inner walls to determine the condition of, and potential damage to, the structure.</li> <li>ASSESS the underside of the roof first (to the extent possible) to determine its condition and potential damage to it.</li> <li>ASSESS the roof to determine its condition and potential damage.</li> <li>Immediately NOTIFY Building Manager of any safety issues identified</li> </ul>
	5.	DOCUMENT the outcome of the assessment by placing an "X" in either the "passed" or "did not pass" box on the <i>Good Faith Roof Assessment</i> cover sheet.
	6.	SIGN the completed <i>Good Faith Roof Assessment</i> form.
	7.	PLACE an "X" in the "did not pass" box on the <i>Good Faith Roof Assessment</i> cover sheet <u>AND</u> INITIAL the entry if a member determines that an engineering inspection is required.
	8.	SEND a copy of the <i>Good Faith Roof Assessment</i> (cover sheet, checklist, and finding sheet) to <a href="#">Hanford Missions Integration Solutions (HMIS) Real Estate Services</a> , the Building Manager (or delegate), and the project's safety manager.

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Actionee	Step	Action
Assessment Team Members	9.	<p>PROVIDE a copy of the "passed" <i>Good Faith Roof Assessment</i> (Site Form A-6004-781) to the requesting Planner/Scheduler or Manager to be made part of the pre-job planning documents.</p> <ul style="list-style-type: none"><li>• A "did not pass" assessment is handled in one of the following ways:<ul style="list-style-type: none"><li>○ It is referred to the engineering inspection team for further investigation.</li><li>○ The activity is canceled and a copy of the assessment is entered into Integrated Document Management System (IDMS) by the Building Manager.</li></ul></li><li>• Newly constructed (within the past calendar year), undamaged roofs may be assessed as follows (in lieu of a good faith assessment):<ul style="list-style-type: none"><li>○ The <i>Good Faith Roof Assessment</i> cover sheet is completed by the assessment team in accordance with this procedure.</li><li>○ A review of the building/roof design specifications is completed by the qualified engineer to verify that the roof will withstand the intended load. If the information contained in the specifications is not sufficient to complete the verification, a design engineer is consulted for assistance.</li><li>○ The reviewer signs the <i>Good Faith Roof Assessment</i> cover sheet and notes on the sheet "newly constructed roof – design specifications verified."</li><li>○ Project safety signs the <i>Good Faith Roof Assessment</i> cover sheet.</li><li>○ The findings from this assessment are indicated on the <i>Good Faith Roof Assessment</i> cover sheet.</li></ul></li></ul>



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## 3.3 Engineering Inspection

Actionee	Step	Action
Building Manager (or delegate)	1.	ASSEMBLE a team to conduct an engineering inspection. <ul style="list-style-type: none"> <li>The team consists of a minimum of three members: Building Manager (or delegate), the structural inspector (qualified engineer), and a safety representative.</li> <li>An engineering inspection may be requested any time at the discretion of the Building Manager, Engineering, or Safety.</li> </ul>
	2.	CONDUCT a pre-job briefing with the team per CPCC-PRO-WKM-14047.
Assigned Engineer	3.	PERFORM strength calculations or review original design to verify that adequate capacity is available to allow personnel access.
	4.	PERFORM the inspection in accordance with Appendix A.
	5.	CATEGORIZE the structural roof inspection results into one of the following: <ul style="list-style-type: none"> <li>SAFE: The roof is safe for normal roof access, which is 20-psf or enough to allow a limited number of workers on the roof, but no storage of materials.</li> <li>RESTRICTED: Only a portion of the roof is safe for roof access, or all or part of the roof is safe for a very limited load, such as two workers only on the entire roof.</li> <li>UNSAFE: The entire roof is unsafe for personnel access until it is replaced or repaired.</li> <li>UNKNOWN: The entire roof could not or was not inspected and should be considered unsafe.</li> </ul>
	6.	DETERMINE <u>AND</u> DOCUMENT in the report, the length of time in which the engineering inspection will remain in effect.
	7.	INCLUDE the passing engineering inspection report with the pre-job planning document(s) <u>AND</u> PROVIDE a copy to the Building Manager.
Building Manager (or delegate)	8.	NOTIFY the project director of failed engineering inspections.

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## 3.4 Completed Assessments/Inspections

Actionee	Step	Action
<b>NOTE:</b>	•	<i>Good Faith Roof Assessments are valid for 1 calendar year.</i>
	•	<i>Engineering inspections are valid for the period indicated in the engineering inspection report.</i>
Building Manager (or delegate)	1.	SEND a copy of the <i>Good Faith Roof Assessment</i> or engineering inspection (cover sheet, checklist, and finding sheet) to <a href="#">Hanford Missions Integration Solutions (HMIS) Real Estate Services</a> , Building Manager, and the project safety manager.

## 4.0 FORMS

*Good Faith Roof Assessment, A-6004-781*

## 5.0 RECORD IDENTIFICATION

All records are to be managed in accordance with CPCC-PRO-IM-10588, *Records Management Processes*.

Records Capture Table

Name of Document	Submittal Responsibility	Retention Responsibility
Engineering Roof Inspection	Building Manager	IRM Service Provider
<i>Good Faith Roof Assessment, A-6004-781</i>	Building Manager	IRM Service Provider

## 6.0 SOURCES

## 6.1 Requirements

Report: U.S. DOE Richland Field Office, DOE Investigation Board Report on Fall-Related Fatality of a Construction Worker at Hanford Site 105-F Building on April 7, 1992, item 5, pp. 5-6, date: May 1992

## 6.2 References

American Society of Civil Engineers Standard, SEI/ASCE 11-99  
CPCC-PRO-IM-10588, *Records Management Processes*  
CPCC-PRO-WKM-14047, *Pre-Job Briefings and Post-Job Reviews*  
DOE-0346, *Hanford Site Fall Protection Program*  
HNF-PRAC-30498, *Roof Assessment Procedure*

## 6.3 Bases

WCH-SD-GN-ER-30012 *Generic Inspection Plan for the Roof Deck and Support Structure for Buildings*

**Roof Assessment Process****Published Date: 03/09/21****PRC-PRO-SH-40112****Effective Date: 03/09/21****Appendix A - Generic Roof Inspection Plan****1.0 PURPOSE**

The intent of this generic roof inspection plan is to provide a means to make an expedient structural roof assessment of buildings at the Hanford Site. This assessment is to be made by a qualified structural inspector and/or qualified engineer following the preliminary assessment procedures given in the American Society of Civil Engineers (ASCE) Standard ASCE 11-99. This roof assessment effort does not provide a qualification of the roof for the design or in-place loads. This inspection does provide a reasonable estimate of the roof loading capacity.

**2.0 DISCUSSION****2.1 Roof Inspection Plan**

Part one is a document search for structural as-built details and vendor information on the roof decking and support structure of each building.

Part two is the formulation of inspection guidelines and completion of the walk down.

Part three is the preparation of the final report. The drawing list, structural evaluation, and the bases for the inspection guidelines are contained in Appendix A.

The required members of the inspection team will consist of a structural inspector and/or qualified engineer, a facility representative, and a safety representative

- The facility representative is responsible for building orientation of the team members and escort during the walk down inspection.
- The structural inspector and/or qualified engineer is responsible for the structural training, visual inspection, and the recording of the findings.
- The safety representative is responsible for ensuring completion of required safety briefings, personal protective equipment (PPE), hazard recognition, and safe path of travel.

At the completion of the inspection walk down of each building, the structural inspector and/or qualified engineer, the facility representative, and the safety representative shall convene an inspection closure meeting. The team members at the inspection closure meeting shall come to a consensus final deficiency list to be reported. The final deficiencies shall be documented and signed by central engineering management.

**2.2 Scope of the Inspection**

Before the walk down inspection begins, the drawing and document search must be completed. The actual walk down consists of a visual inspection of selected structural elements of the roof (roof decking and support members only). The walk down will start with an under-the-roof inspection of these structural elements. The walk down will then proceed to the roof top, if necessary, to document in-place equipment loads. The access pathways and stairs to elevated portions of buildings should be structurally inspected before proceeding with the walk down.

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The inspected roof members are limited to the roof deck and its immediate support members. If the deck is supported by beams, then the inspection shall end at the beam-to-girder connection. If the deck is supported by beams that connect directly to columns, then the inspections shall end at the beam-to-column connection.

If the structural inspector must go onto the roof, then a hold point and life-safety assessment shall be performed. This life-safety assessment is a review by safety, facility and structural representatives of the structural adequacy, any fall protection requirements, and safety concerns of walking on the roof. This assessment shall have concurrence by safety and structural representatives and facility and structural managers that the necessary precautions have been taken to ensure safe access and remove the hold point. All facility safety rules in force at the time of the inspection shall be followed.

The document search and walk down inspection provide the initial screening to identify modifications and components with questionable structural integrity. The assessment consists of baseline dead and live load stress calculations of these questionable components and is based on original design material strengths. No attempt is being made to evaluate understrength materials or material degradation that cannot be verified visually. **Neither detailed analysis nor remediation design of deficiencies found during this inspection are part of this work package.**

**3.0 INSPECTION GUIDELINES, QUALIFICATIONS, AND TRAINING**

The structural inspection guidelines for roof decks and their supporting members are listed below. These guidelines are for a screening type visual walk down inspection of the roof. The roof decks and integral structural members shall be inspected to these guidelines, and a simple pass or fail judgement made by the structural inspector. A "component fails" determination indicates only that further structural investigation is required. The facility representative will initiate appropriate action to establish access restrictions, report deficiencies to the facility manager, and provide for further evaluations or repairs. Structural members of all roof areas are to be inspected or noted otherwise and documented in the field notes accordingly.

Identification of the elements constituting a critical load path must be determined by the structural inspector. The structural bases for the following guidelines appear in Appendix A, and the inspection results or field notes will be placed in Site Form A-6004-781 *Good Faith Roof Assessment*. A conservative "component fails" determination should be made when doubt exists about the acceptability defined by these guidelines.

**3.1 Inspection Guidelines**

The following guidelines are to be observed in the order listed:

1. If available, as-built and construction drawings and specifications are to be reviewed before the walk down to gain building familiarization and to check for design irregularities.
2. Visually inspect for deterioration in critical load paths of structural roof members considering the following items:
  - a. Cracks, spalls, or chips in concrete members
  - b. Exposed rebar in concrete members

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- c. Rust stains that indicate rebar corrosion inside concrete members
  - d. Cracks, splits, rot and holes in wood members
  - e. Broken or missing connectors in wood members
  - f. Rust scale, or holes in metal deck and support members
  - g. Dents, kinks, bends in metal roof members
  - h. Broken, cracked, or missing welds and bolts in metal roof members
  - i. Evidence of leakage, damage, or repairs
- 3. Physical modifications or changes in member configuration shall be checked against the associated existing drawings
  - 4. Obvious sagging, buckling, instability, gaping or offset of roof members
  - 5. Notes shall identify which structural elements were examined and which were not.

**3.2 Structural Inspector and/or Qualified Engineer Qualifications**

- 1. Engineers with degrees or equivalent work experience in structural, civil, or mechanical engineering fields.
- 2. Experience in the type of building construction such as steel, concrete, or wood, that is being inspected.

**3.3 Facility Representative Qualifications**

- 1. The facility representative shall be authorized by the facility manager and have complete knowledge of the safety rules, restricted areas, and required entrance training for the building being walked down.
- 2. The facility representative shall be responsible for obtaining access permission, craft support, and removal of in-the-way equipment or false ceilings.

**3.4 Pre-Inspection Training**

- 1. Discuss in detail the inspection guidelines and bases from A2. (Structural Inspector)
- 2. Discuss inspection field note forms and how they should be filled out. (Structural Inspector)

**4.0 DEFICIENCIES****4.1 Deficiency List Summary**

This section is to be completed after the walk down inspection, based on information in Appendix A, 6.0.

**4.2 Recommendations**

This section is to be completed after the walk down inspection.

**5.0 REFERENCES****5.1 American Society of Civil Engineers Standard ASCE 11-99, *Guideline for Structural Condition Assessment of Existing Buildings***

**Roof Assessment Process****Published Date: 03/09/21****PRC-PRO-SH-40112****Effective Date: 03/09/21****Appendix A - (Cont.)****6.0 INSPECTION GUIDELINE BASES**

The following pages present descriptive information for the inspection of roof structures at the Hanford Site. The walk down inspection is a screening type structural inspection to be performed by qualified structural and facility engineers. This being a visual inspection, the guidelines are somewhat abstract and rely heavily on the judgment and experience of the inspecting engineers.

**6.1 Metal Decking** (Reference, ICBO Evaluation Report No. 2078, and Vulcraft Steel Floor & Roof Deck engineering manual)

Metal roof decks at the Hanford Site are normally constructed in one of the three following configurations; metal decks covered with unreinforced concrete, decks covered with reinforced concrete, or uncovered metal decks. In the Unreinforced Concrete (UC) configuration, the metal decking is the structural member that resists all the loads and the concrete is intended only as a wearing surface. In the Reinforced Concrete (RC) configuration, the metal deck is used as a form and the concrete or the combination of deck and concrete is the structural member. In the Uncovered Deck (UD) configuration, the decking is both the structural member and the wearing surface but is generally not intended to carry equipment loads or to be walked on.

**6.1.1 UC Deck**

In this type of decking rust scale or rust holes on the metal deck reduces the deck capacity, however cracks in the concrete have no effect. Holes that are not shown on the design drawings may be acceptable in low stressed areas only. Acceptability should be based on the remaining undamaged strength and the stress at that location. Connections between the deck and supporting members should also be reviewed for strength.

**6.1.2 RC Deck**

Rust or holes in this type of deck may have an effect on the strength of the steel deck and should be checked very carefully. If the concrete is reinforced to act alone as the structural member then rust in the metal deck should not be a problem. If the steel deck acts compositely with the concrete as the structural member then rust in the metal deck may compromise the structure. Composite steel decks can be confirmed either by drawing callout or by the presence of shear locking indentations on the vertical legs of the deck corrugations.

**6.1.3 UD Deck**

Rust or holes in this type of decking reduces the capacity and is not acceptable in the high stressed areas. This type of decking is more susceptible to dents or kinks than any other type of decking, the dents and kinks should be treated the same as if they were holes in the decking. Acceptability should be based on the remaining undamaged strength and the stress level at that location.

**Note:** *Metal decks are normally attached to the roof supports with welds, and these should be checked for broken or missing welds or any other type of fastener.*

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Cracks in concrete are both common and expected, and if small (ACI-224R code limit is .016 in.), do not affect the load-carrying capacity of a concrete slab. Large cracks (greater than .016 in.), cracks with spalling around them, and cracks with rust stains indicating rebar corrosion and a loss of sectional area, are not acceptable. Chips and spalls without associated cracks are normally acceptable in tension zones if no rebar is exposed. Exposed rebar is not desirable but may be acceptable if there is no sign of rust and the bar is not within one Development Length (DL) of a support or point load and not exposed for longer than one DL. Holes or cut-outs in slabs may be acceptable based on stress and location.

**6.2.1 Definition**

Rebar DL - The Development Length (DL) of a rebar is the length of concrete embedment in inches required to obtain full strength of a rebar.

Spall - A fragment detached from a larger mass by a blow, by the action of weather, by pressure, or by expansion within the larger mass.

Chipping - Treatment of a hardened concrete surface by chiseling.

Holes - Holes that do not cut through rebar are acceptable, holes in middle and column strips may not cut more than 1/4 of the total number of rebar in that strip.

Strip - A strip is the term used in two-way slab design to designate slab areas in the middle of the slab or the slab running along a beam between two columns.

**6.3 Precast Concrete** (Reference ACI-301 & 318)

Precast concrete panels have the same limitations as cast-in-place concrete with some additional considerations. Large cracks (greater than .016 in.), cracks with spalling, and cracks with rust stains originating within the cracks are not acceptable. Chips and spalls may be acceptable if the rebar is not exposed, or if the rebar is exposed, the exposed length is less than one DL and not closer than one DL to a support or point load. All cracks in the outer third of the panel spans are suspicious and should be inspected carefully.

The precast panels do not have the ability to redistribute load when cut-outs are made as do cast-in-place slabs. Hanford Site precast panels are constructed with two ribs each with one rebar. If one rebar is cut or rusts away, the panel may fail suddenly. Large cracks (greater than .016 in., cracks with rust stains, or cracks with spalling in the rib of the panel is unacceptable. Small cracks (less than .016 in.), chips, holes, or spalls may be acceptable if the DL limitation above are not exceeded. The area between the ribs is reinforced with wire mesh, and should be checked for rust areas and large cracks.

**6.4 Wood Decking** (Reference, Western Lumber Grading Rules, 2017, WWPA)

Wood decks may be plywood or plank type decking. Plywood is better than planks of the same size because it can accommodate more and larger holes for the same percentage loss of strength. Plank type decking should be inspected to the guidelines given in the wood joist section. Splits, checks, skips, and shakes as defined in the wood joist section due not



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normally occur to plywood panels. Plywood and plank type decking that is discolored, broken or with holes in the high stressed areas is not acceptable. Connections to support members and along edges should be checked for loose or missing bolts or nails.

**6.5 Steel Beams** (Reference AISC 14th Edition)

Many types of steel beams are used in roof construction, including wide flange beams, I-beams, plate girders, channels, or sheet metal bent to form channels and Z shaped members. These roof beams should be checked for heavy rust scale and rust holes, dents, kinks or other misalignments. Cut-outs and supported loads not shown on the drawings. End connections should be checked for cracked or broken welds, loose or missing bolts, and distorted seat or clip angles members. Welds made to a beam flange while the beam is loaded produces a yield point in the member and is not acceptable. Lateral support for the beams should be reviewed using the building drawings and checked in the field.

**Holes in Web** - Holes in beam webs due to rust, bolt holes, or cut-outs, reduce the shear capacity of the member near the hole. Normal bolted connections reduce web area by 25% or more by drilling and coping, this is generally a reasonable reduction anywhere in the beam web.

**Holes in Flanges** - Holes in beam flanges are not as common as in beam webs, and have more structural implications. Holes in beam flanges that are not shown on the drawings and are in high bending stress areas are not acceptable. Holes in other locations may be justified based on the stress level and loss of sectional area at that location. The AISC limit for holes in the flanges that do not effect stress is 15%, AISC 1.10.

**Dents & Kinks** - Dents, kinks, and misalignments can cause a sudden buckling type failure of beam member. Because of this sudden failure mode, these deficiencies cannot be allowed in a compression stress zone.

**Connection** - The described connection deficiencies can cause sudden failures modes and cannot be allowed.

**6.6 Steel Joists** (Reference, 50-Year Steel Joist Digest, SJI)

Roof joists are small truss type bending members fabricated from steel angles, plates, bars, and rods. Joists are lighter and thinner than beams for an equal load carrying capacity; but can accommodate fewer defects or damage and still remain functional. Joists also require more lateral support than beams because they are thinner. Where some holes in beam webs and flanges may be acceptable; in joists they are not.

**Holes** - Holes and cut-outs in any member are not acceptable in joist construction.

**Dents & Kinks** - Dents, kinks, and misalignments can cause sudden buckling type failure of the member. Misalignments in joist construction are allowed to be 3/4 times the least member dimension. Other misalignments, dents, and kinks are not acceptable.



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Connections - Connections are allowed to have the same tolerances as misalignments; 3/4 times the least member dimension. Connections also are designed with a higher safety factor; they are designed for 3 times the design stress. End connection lengths are based on the supporting materials; usually 4 in. for concrete or masonry, and 2.5 in. for steel.

**6.7 Concrete Beams** (Reference ACI-301 & 318)

Cracks in concrete are both common and expected, and if small (ACI-318 code limit is .016 in.) do not affect the load-carrying capacity of a concrete beam. Large cracks (greater than .016 in.), cracks with spalling around them, and cracks with rust stains indicating rebar corrosion and a loss of sectional area, are not acceptable. Chips and spalls without associated cracks are normally acceptable in tension zones if no rebar is exposed. Exposed rebar is not desirable but may be acceptable if there is no sign of rust and the bar is not within one Development Length (DL) of a support or point load and not exposed for longer than one DL. Holes or cut-outs in beams may be acceptable based on stress and location.

**6.7.1 Definitions**

Rebar DL - The Development Length (DL) of a rebar is the length of concrete embedment in inches required to obtain full strength of a rebar.

Spall - A piece of concrete that has broken away from the rest of the concrete member due to a hit from the backside of the member, or when corrosion within a member pushes the piece outward.

Chip - A piece of concrete that has broken away from the rest of the concrete member for any other reason.

Holes - Holes that do not cut through rebar are acceptable, holes in other areas should be reviewed for stress and location.

**6.8 Wood Joists** (Reference Western Lumber Grading Rules)

Wood joists are visually graded by standard grading rules such as the Western Wood Products Association (WWPA). These grading rules are for "Number 2 Select Joists" and will be used in part as the guide for this inspection. Wood joists also rely on the wood decking to provide lateral buckling support. Loss of connection between deck and joist is unacceptable. The following grading information is taken from the Western Lumber Grading Rules 1988 edition as published by WWPA.

**6.8.1 Grading Information**

Checks - Seasoning checks not limited. Through checks at ends are limited as splits.

Shake - On ends limited to half the thickness. Away from ends through heart shakes up to 2 ft long, well separated. If not through, single shakes may be 3 ft long or up to 1/4 the length, whichever is greater.

Skips - Hit and miss, and in addition, 5% of pieces may be hit or miss or heavy skip not longer than 2 ft.

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Splits - Equal in length to 1.5 times the width of the piece.

Unsound - Not permitted in thicknesses over 2 in., but in 2 in. thickness, heart center streaks not over 1/3 the width or thickness, or small spots or streaks of fine honeycomb or peck equal to 1/6 the width are permitted.

Holes - Evenly spaced holes for any cause, 1 3/8 in. in widths less than 12 in. and 3 in. for 12 in. or greater are permitted.

**6.8.2 Definitions**

Check - A separation of the wood normally occurring across or through the rings of annual growth and usually as a result of seasoning. A through check extends from one surface of a piece to the opposite or adjoining surface.

Shake - A lengthwise separation of the wood that usually occurs between or through the rings of annual growth. A through shake extends from one surface of a piece to the opposite or to an adjoining surface.

Skips - An area on a piece that failed to surface clean less than 1/8 in. deep and 12 in. long on a face and 24 in. long on an edge.

Splits - A separation of the wood due to the tearing apart of the wood cells.

Unsound - Soft wood areas with little or no strength, this would include wood rot.